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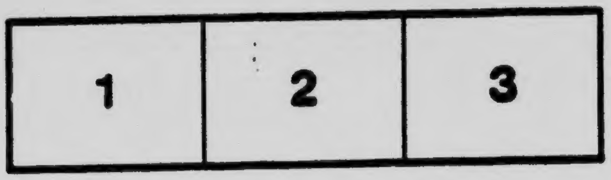

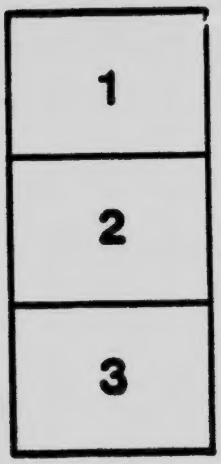

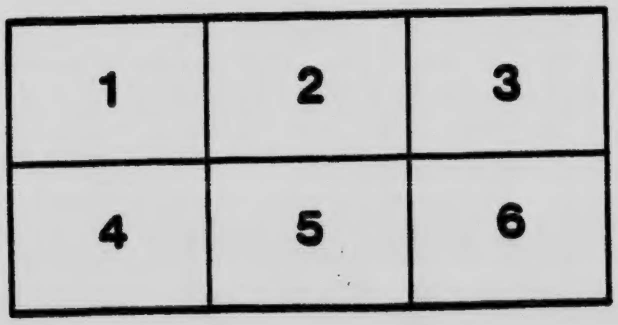

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BULLETIN 224] [SEPTEMBER, 1914

Ontario Department of Agriculture

VEGETABLE GROWERS' ASSOCIATION

Greenhouse Construction

By S. C. JOHNSTON, B.S.A

INTRODUCTION.

Recognizing that the production of vegetables under glass has been and is rapidly becoming one of the important branches of agriculture, the Ontario Department of Agriculture, at the request of the Executive of the Ontario Vegetable Growers' Association, deemed it advisable to investigate the types of construction of green houses used by American growers. This investigation work covered the principal vegetable growing districts of the Northern and Eastern States, and the following report is intended to convey to the prospective builders some of the details of construction which may help to solve the problem of what is the most economical form of house to build, and other points which should be carefully dealt with before the house or houses are begun. The object of this investigation trip was to find the lightest, most durable and most economical type of construction backed by the experience of growers in all parts of the states visited. Over one hundred greenhouse plants were visited and the experience of the several growers taken, and all information possible was gathered which might be of use in this line.

The growing of vegetables under glass is yearly becoming one of the very important ends of the vegetable grower's business. Intensive cultivation of the land out of doors during the summer months has increased the demand for large quantities of fresh produce during this period, and gradually the consumer has begun to want fresh vegetables on his table the year round. The building of structures covered with glass and supplied with artificial heat have been introduced, and by their use the vegetables are grown to perfection, thus supplying the demand for vegetables each day of the year.

The greenhouse business in Ontario, of course, has not advanced to the degree that it has in the United States, but within the last five years there has been an increase in the building, and there has been considerable improvement in the forms of construction. At the present time in Ontario there are several large plants devoted entirely to the production of vegetables, and a considerable number of the vegetable growers in all districts of the Province have small plants from which they take several crops of lettuce during the season and later use as a starting house for their field crops for the summer. At the present time large quantities of greenhouse-grown vegetables are annually imported into Ontario from the United States. These are principally tomatoes, cucumbers, and lettuce, and by referring to the reports of the Department of Customs it has been found that during the winter months of December, January, February, March, April and May the imports into Ontario alone of the one vegetable, tomatoes, have amounted to in the neighbourhood of $10,000 per month. The other above-named crops come in probably at the lesser rates. A certain percentage of these vegetables are grown under glass by men working large establishments, and who devote practically all their time and ability to the production and selling of indoor-grown crops. Ontario growers are not producing one-half of the indoor vegetables which are being consumed in the Province at the present time, and the demand is increasing daily. Growing these crops under glass is not the easiest occupation to be found. No amateur should be misled and think there is a fortune in greenhouse vegetables. Because the crop has to be grown under artificial conditions, and because these conditions are many and of a very intricate nature, the grower has to be on the alert the whole season through to prevent as far as possible the many causes which check the growth and development of the tender plants in the middle of winter. Heating, ventilation, methods of planting, etc., are conditions which he can control, providing a first-class greenhouse is erected at the start. The grower should build the very best construction his means will allow. A cheaply-built house is always a source of worry and expense, and the time has come when durability is looked into far more than initial cost. We hear complaints on all sides of the inability to secure competent labor at a reasonable or unreasonable cost. From the gardener's standpoint this is principally because he has work for men during only six or seven months of the year. Progressive growers in several parts of the have overcome the labor problem by building a greenhouse plant and thus employ a certain amount of help the year round. During the summer months, when the greenhouse does not need so much attention, these men are available for work on the outside. The grower is money in pocket by making at least a certain part of his land produce both winter and summer. In this way his help is steady, and the labor problem does not bother him.

CO-OPERATIVE BUILDING.

In the vicinity of Cleveland, Ohio, there are several ranges which have been built on a co-operative scheme. Several growers having money to invest in greenhouse lines formed a co-operative society, and with the bulk of their capital built a large range and are producing vegetables only. They have a range of modern construction, and it is being managed by a competent grower who receives a stated salary for his services. He is directly responsible to the Board of Directors, and has practically free charge. This co-operative idea spread, and now three large ranges are being conducted along these lines in a very satisfactory manner from a financial standpoint to all concerned. Two of the three have enlarged their plants already, and the other one will be added to in the coming season. Dividends are large, and there is a feeling that the investment has been wise. Why not this same idea in some parts of Ontario?

LOCATION.

To the persons who are starting a new house or range, certain points must be looked into carefully. Nowadays any point which means a saving of labor is considered a good investment, and for this reason the greenhouse should be located in the best possible place from a labor-saving standpoint. Possibly the securing of fuel at a reasonable cost is the largest item for consideration, and next to that the marketing of the produce. Where the grower is at liberty to start his plant close to a railroad—either a steam or an electric line, which will haul freight and express—he has considerable advantage over those who cannot. The proximity to a railroad which assures good service is a very valuable asset to a greenhouse grower, and should be carefully looked for before an extensive plant is built. Long hauls of fuel and supplies mean an added outlay of capital which should be invested in the plant. At the present time as much of the hauling operations are being eliminated as possible and being done by means of having a switch right on to the owner's place, and in the majority of new plants running up on a trestle so that the coal can be unloaded into the coal hoppers or bins with the least possible amount of handling.

Boiler Room Located so as to Minimize Hauling Operations.

A few years ago it was considered a wonderfully up-to-date plant which had the car unloaded outside the boiler house door and the coal then hauled in by means of wheelbarrow or dump cart. That is all changed, and the coal is simply dumped, with very little labor, into the bins located close to the boiler. The vegetable grower marketing his produce at a local market spends much of his time on the road, and for this reason good roads are a necessity and a benefit to the vegetable grower, as they allow the produce to be taken in in a much shorter time than over rough, rutty roads. The buying public are now demanding quality rather than quantity, and will not accept bruised tomatoes or crushed or wilted lettuce. The grower who carries his produce over a good road realizes more for it than the one who has had to jar his goods over stones and through ruts. Growers in some parts of the States have done much toward securing better means of travel to and from their market, and claim that they are making considerably more than in the old days.

Prospective greenhouse builders looking for a location should consider this point and select a site either on or close to a good road.

The growers in some districts do not attempt to sell their produce locally. They ship by express to cities and towns within a radius of 150 to 200 miles. To them quick, safe and certain service is necessary, and they use both electric and steam roads; some even build switches into their plants from an electric line for fast service. With the coming of radials into Ontario, and the increasing demand for greenhouse vegetables, the grower does not of necessity have to locate his plant close to the market of one large city. A central location with the aid of electric and steam roads will give him the whole of the Province as his market. To the man who wishes to build a house or range on the piece of land he now has there are certain other points which apply to him as well as the man seeking a new location. First and foremost the plant must not be built in a low place. Several plants visited this year were giving trouble by being too low and too close to a stream which flooded very much in the spring. Several plants had crops totally destroyed by being in the path of an extra strong spring freshet. Again, the houses should not be located so as to receive the full force of the prevailing winds. This has been overcome by some growers by the planting of quick growing trees to form a windbreak, or in other cases by simply building a high, tight board fence to break the direct force of the wind. To sum up, the points to be considered in choosing the location and site for a greenhouse plant are as following:—

1. Long hauls and re-handling increase the cost of production.
2. Proximity to railroads lessens hauls and handling, thus lessening cost of production.
3. Good roads mean good quality and better returns.
4. Low places should be avoided, and care taken not to locate where there is any danger of spring freshets.
5. Being in the direct path of the prevailing winds increases fuel consumption. Where possible windbreaks of trees should be used, or high, tight board fences should be built.

FOUNDATION AND WALLS.

The most important part of any structure is its foundation. A first-class superstructure having a poor foundation will cause more trouble than a first-class foundation at the beginning. Builders should aim to have a strong foundation of e very best materials. This should be of concrete, as a permanent structure is equired, and as a rule should be eight inches in thickness and should be set in the round sufficient depth to give a good foundation and be below the frost line. The alls should be of concrete, wood, wood and shingles, or siding or concrete blocks. s a rule the walls are not built higher than two feet, while some prefer them three nd others wish only one foot of wall, the remainder being of glass. Twenty-four nches of a solid wall seems to be about the right height, and this allows four feet or side wall ventilation purposes where six feet eaves are used. Wood in any form s rapidly being replaced with some form of concrete, either solid or as concrete locks. Both forms are substantial, and will give satisfaction. Some growers prefer the concrete blocks because they can make them during the winter months when not busy. The only point to remember in making blocks is to make them so as to fit exactly to the pipe or iron gutter supports. Concrete work of any description should be carefully done so as to give the outside walls an attractive appearance. As the foundation is to be lasting it should be smooth and uniform, so that the whole plant will have a pleasing appearance. Some growers prefer a three-foot wall of solid concrete, and while this is not advisable on account of the need of plenty of side ventilation, those who so desire should leave openings about every ten feet in order to facilitate the handling of rhubarb roots, manure, or soil. These should be fixed with a small door and should be built so as to fit snugly. Much time can be saved by the use of these doors in bringing in the season's supply of rhubarb roots or new manure for the beds or benches.

DRAINAGE.

Some soils require drainage around the walls to prevent frost action. These should be of 2 or 2½ inch tile and set at base of foundation on the outside. Care should be taken to secure a good outlet for these drains. These drains are usually set one foot away from wall. Some growers use posts for their side wall supports. These are only advisable under certain conditions. Where only a temporary house is needed whole cedar posts set 3 ft. in the ground, 4 ft. apart, are what are usually used. Tile drains are needed both inside and out, as mentioned before. In these houses the walls are usually sheeted with inch lumber, then grey building paper one thickness and clap boards, or Manitoba sheeting or shingles used for the outside. Shingles are not advised because they will curl with the sun's heat. Clap boards or siding cost practically the same and will last longer and give less trouble. Tar paper should never be used on the walls as the fumes will kill the plants inside.

HEIGHT OF EAVES.

During the past five years there has arisen considerable controversy among greenhouse builders and growers as to what was the best height at which to have the eaves. Here, again, there seems to be various opinions which suit only individual conditions. Years ago it was considered almost necessary to have no side to the greenhouse at all, running the sash bars down to the plate, which was nearly always set on top of the ground. Since then great advances have been made in construction and we now find greenhouses and eaves ten feet from the surface of the ground. This is rather high, and is the idea of one man, and he claims he has the best. It is quite common to see eaves six to six and one-half and seven feet in height in large commercial plants. This, as with many other points in greenhouse construction, is modified to suit conditions and to cut down the cost of production. High eaves are built in the first place to allow plenty of head room for growing plants, such as tomatoes or cucumbers, which need stakes or trellis work for support. To give this necessary head room the eaves are usually built six and one-half or seven feet. This gives ample room for glass sides and also side ventilators. It is recommended on any house thirty feet or over that the eaves be placed at least six feet above the level of the surface soil. Lower eave plates than this cause endless knocking against the roof members and greatly hamper the economic handling of plants.

DIRECTION OF THE RIDGE.

Different ideas are prevalent with regard to the direction of the ridge of a greenhouse. Many experienced growers prefer to have the ridge run east and west, and many others have a preference toward having the ridge run north and south. In the old style house, where the sash bars were heavy and close together, there was more room for argument on this question, but to-day, when the wide houses are being built of materials which cut down the possibility of shade to a minimum, it seems that houses running east and west and north and south give equally as good results. The question of the direction of the ridge is an open one, and, as said before, different growers prefer each. It seems that this point has been given altogether too much attention, and the result of investigation regarding it leads to the following conclusion: Build the house facing either south or west, according to the location which you have. While men favor both east and west and north and south, the majority seem to favor east and west, but can give no specific reason for so doing.

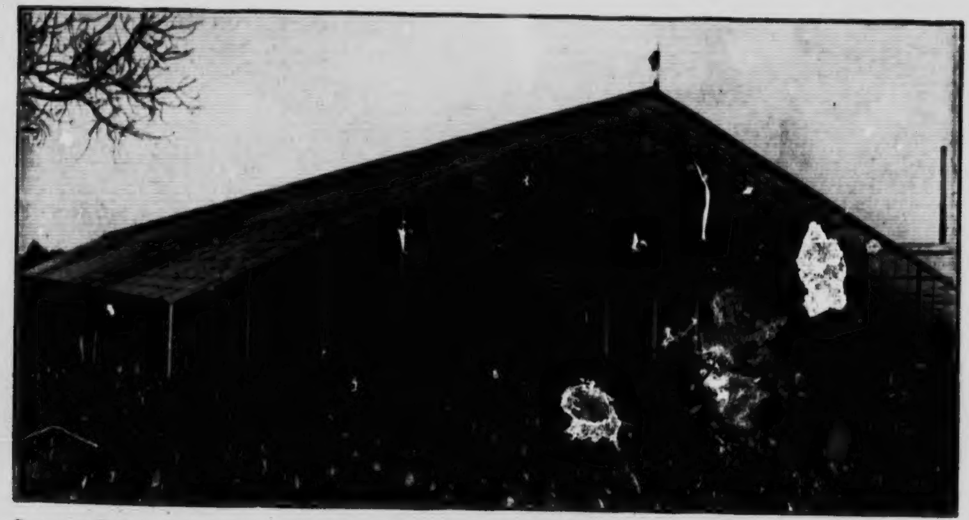
Previously only narrow, low roofed houses were used, but wider ones are now the only ones in demand. The change from 14 ft. to 75 ft. houses can plainly be seen here.

WIDTH OF HOUSES.

Practically all greenhouses built up to the last fifteen years have been of comparatively narrow widths. This has been due largely to the mistaken idea that the plants should be located as near the glass as possible. During later years this idea has been misproven, and houses are now being built much wider. The large greenhouse growers are convinced that better returns can be received from houses of a wider span than from the old fashioned narrow ones. In houses having a wider span, and of necessity higher eaves, the volume of air is increased, the glass surface is proportionately increased, and the working cost of the greenhouse is lessened. The volume of air is increased due to the increased length of the sash bars and the increased height of the eaves, and this is what greenhouse men require for successful growing—more air. It is an experiment no longer, but an actual cultural necessity, to have plenty of air over the plants. The plants grow better in every stage, and are not so liable to suffer so much from the sudden lowering of temperature. With the increased length of sashbar, etc., the glass surface is increased, and this admits more light and also makes adequate ventilation easy.

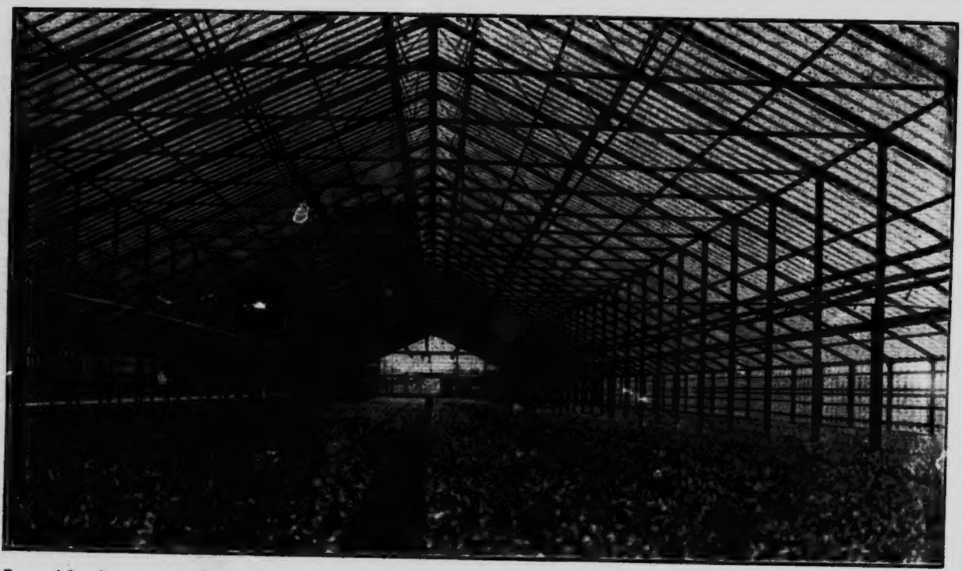
With the higher eaves the ventilating apparatus can be easily placed and operated, taking up practically no room in the house. The working cost or crop costs are several per cent. cheaper in wide houses than in the old narrow ones, because the houses have higher eaves, and cultural operations can be carried on close up to the sides without fear of bumping into the sash bars, etc., as is common on going into the narrower houses.

Widths of houses are arbitrary to the builder. The prevailing width of house being built at the present time in the United States seems to be seventy-five feet. Many plants have passed from the twenty foot width to the twenty-five foot and then to the forty foot, and experienced men seem to agree that the seventy-five foot house gives them as nearly a perfect house as they can get. The forty foot house has been built extensively by many vegetable growers, and gives entire satisfaction; but as soon as the seventy-five foot house has been operated a season 95 per cent. of the growers will have no others.



Seventy-five foot houses are preferred by the majority of large growers. The doors in this 75 x 460 ft. house admit all cultivating machinery.

The increased facilities of handling materials, supplies and soil cut down the cost of production in the wider houses at a greater rate than in the narrower houses. Conditions alter cases. For this reason the man who is starting a small plant could not afford to build the length of house in keeping with the wide houses, and for this reason he should insist on getting just as wide a house as his means will allow. For the man growing greenhouse products during all the winter it is not economical to build a house less than forty feet in width. Much better that he build over forty feet in width and not so long, than a long narrow house which prevents the easy handling of all parts of work, etc. It is cheaper by far to add to a wide house after a few years than to tear down a long narrow house and rebuild it. Narrow houses have their place, quite true, and many are making good returns from large plants of narrow houses; but, on the other hand, they are seeing the point of the wide house, and in many cases rebuilding. For the grower on ten acres of land who wishes to have a house to grow lettuce in during the winter and use as a plant house towards spring, it is just possible that a house twenty-five feet in width will give as good results where the heating and ventilating are carefully looked after. On the whole it will pay any man who is building a greenhouse at all to put up a house of wide span, because he has more room, better control of ventilation, less chance of disease, and the heating cost of the wide house is considerably less than that of the same width made up of several narrow houses.



In wide houses the crop can be handled with minimum expense. Horse-drawn implements were used to prepare the land here for this crop. Interior of previous view.

IRON FRAME CONSTRUCTION.

Possibly this form of construction is receiving more attention at the present time than any other. Growers in many sections of the United States are finding that the best is none too good, and the iron frame greenhouse meets with their approval better than any other. Prominent vegetable growers in the vicinities of Boston, Rochester, Erie, and Philadelphia, who are competent men on greenhouse construction details, favor this form, and back it up by securing more houses as their demand increases. They are the best judges as to the value of these houses.

Description.—In houses of the iron frame construction all possible parts are constructed of iron. Flat iron posts bolted together set in concrete form the supporting members for eaves, etc. Flat iron rafters run from these wall supports to the ridge, being held together with angle iron purlins. The sash bars are of wood and are attached to this iron frame work. In a few words, this construction simply is a frame of iron which supports the sash bars on which the glass is laid. It has been found that metal cannot take the place of wood in manufacturing; owing to the expansion and contraction of the metal in different weathers.

Iron frame construction—showing the iron member which acts as the supporting part of the house. Solidity is the feature here.

For this reason wooden bars are used to support the glass, and thus breakage is checked.

Different manufacturers vary somewhat in the forms of iron that are used, some using flat iron others T iron and others ordinary galvanized pipe for their supporting members. The majority of growers seem to favor the flat iron rafter house, that is a strip of iron runs from wall post to the ridge at intervals of eight feet four inches or thereabouts. As a rule this distance has been found to be the farthest apart that these iron members may be set without sacrificing strength and support. These iron frame houses are all bolted together, so that once the structure is properly erected the house is strong and substantial. Houses of this construction practically cut out all supports in the house, and this is what the vegetable grower requires.

Houses 40 ft. in width may be constructed with no central supports whatever from the ground, using only a form of compression trussing which holds the house together and down. A house 75 ft. in width will require but two lines of supports with braces and struts.

WIDTHS.—These iron frame houses can be built any width a grower wishes. It is not economical to use this form of construction in a house under forty feet in width, but it is not advised to build over 75 or 85 ft. in width. Many houses 75 ft. in width are being built throughout the States, as well as a few in Canada, and this width seems to be an economical one to use. Houses 40 ft. in width with no supports save the truss work also are very much in favor.

ERECTION.—These iron frame houses are all manufactured in separate pieces in foundries, iron parts cut required lengths, all holes bored and the house in many cases set up to see that everything fits before being shipped on to the builder. The parts are all properly labeled, and a blue print of the plan of the houses showing details which accompanies each house gives the exact position for each member. It is no trouble to erect one of these iron frame houses, for the whole house goes together in sections, and once one section is satisfactorily erected the remainder of the house goes together like clock work. Growers differ as to whether it is more economical to erect the house by means of home labor or by letting the contract to a construction company whose employees do nothing else but erect these houses. One grower in the vicinity of Boston purchased a house from another grower, took it down and re-erected it for himself, and says he had no trouble whatever; in fact he claims to have made a better job than some of the construction firms would have done. Another grower near Erie erected a house 75 by 460 ft. from start to finish, and one would not wish to see a better house. A man with average mechanical ability can erect a house of this construction with very little trouble, but whether it will pay him to do so rather than let the contract to a firm who make a business of this erection is a question. Some progressive men told me that they were money in pocket when they gave the construction company the contract to do all the work on the house. They claimed that they more than made what it cost them to erect the house by being free from all worry, and being able to look after the selling of the produce on other parts of their plant. It is simply as the man himself looks at it, and whether he has the time to look after the erection himself and bear the responsibilities of having it go together in good shape.

Ontario growers should use this form of construction in preference to others under certain conditions. In the first place these houses cost in some cases more to build than other forms of houses of other construction. The initial cost is high, there is no question about it. But this must be borne in mind by all prospective builders: that once one of these houses is up it is up to stay, and will last as long as the grower and still have a further lease of life. Houses which cost much less to build at the start soon show effects of wear and tear. In ten to fifteen years time they need many repairs, and in many cases require new stock all through. Not so with greenhouses in which a framework of iron is used. They are still giving entire satisfaction at the end of thirty years' service. The iron greenhouse gives a solid house which no wind can blow in or out. This has been proven in Ontario and in parts of the United States during the past two years. The iron work when properly made and erected can weather the worst of storms. No vibration of glass is seen in a windstorm, in fact practically no motion is felt in any part

Iron frame houses are easily erected. All parts are bolted together in order to have a solid frame. The eave supports are set in concrete first and then the iron rafters are raised to position. This view shows house in various stages of erection.

of the house. The average grower will think on the face of things that a house of this form of construction will cost more to heat.

This has been tried out by growers themselves, and they have found that once they get a house to the correct heat it costs considerably less to keep it there. The iron frame houses are usually built wider and higher, and the volume of air helps a lot in lessening the fuel bill; but the very fact that the iron frame house is so rigid and in this way allows no openings for air to get in, no spreading of joints or pulling out of nails or breaking of sash bars with over-load of snow, the cost of heating one of these houses is cut down in some cases one-half that of the same area under houses of other construction. The advantages of iron frame greenhouses and the merits of this construction may be summed up as follows:

1. Cost of upkeep very small as compared with other forms of construction.
2. Solidity. The houses of this form have been in use thirty years and are still in good condition.
3. Cost less to heat.
4. Glass breakage is considerably less.
5. Lack of columns.
6. Minimum shade.

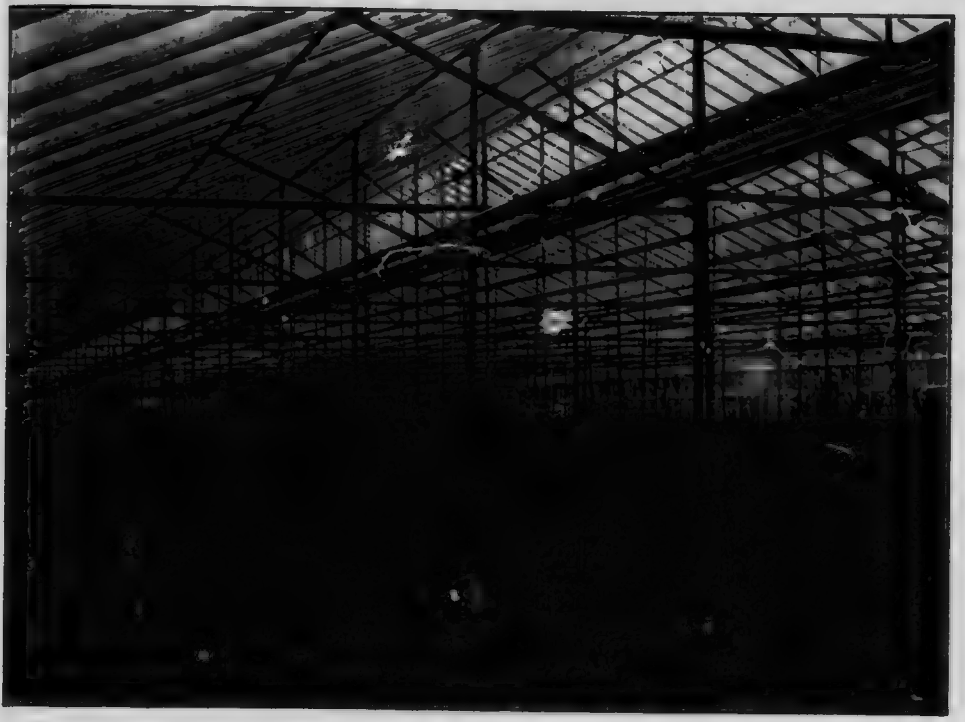
OBJECTIONS.—The main objection to houses of this construction is that of initial cost. This is often higher than that of inferior forms. To offset that the growers should figure that these are permanent houses built to stay. The upkeep is cut down because there is very little in the house to wear out. Iron frame houses are about as good an insurance as any grower can get for good crops. If he cannot grow crops in these houses he cannot in any other, that is certain. Growers agree that the best is none too good, and a poor thing is dear at any price; and those who have used houses of this stamp recommend them without any hesitation as being the lightest, brightest and most economical houses on the market.

PIPE FRAME CONSTRUCTION.

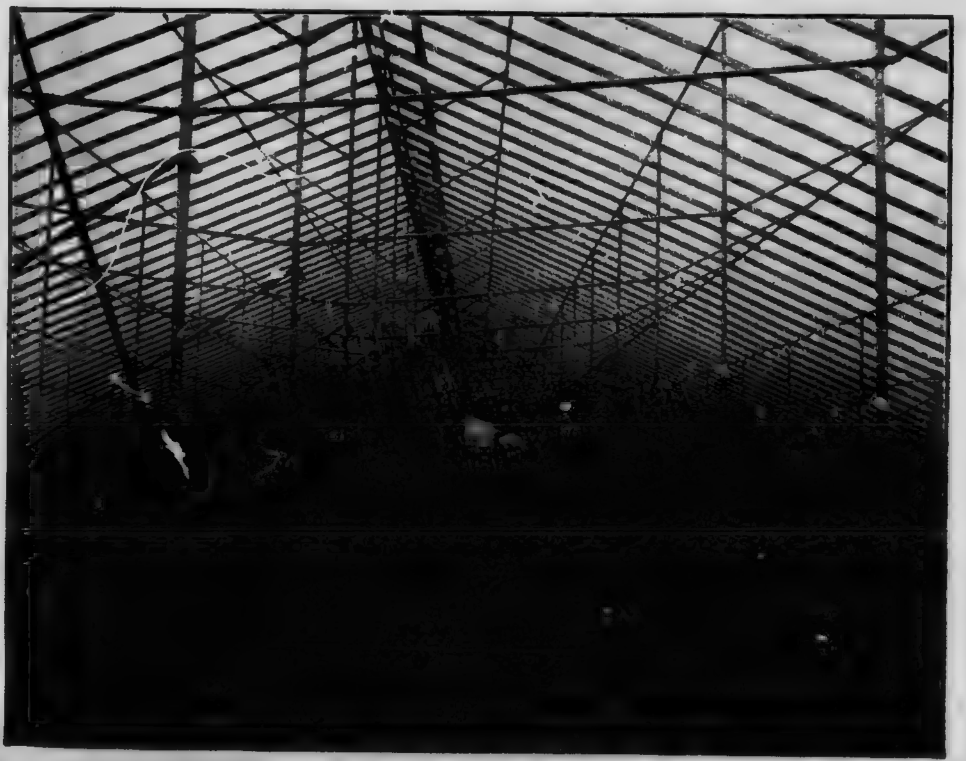
For growers having limited capital or those not desiring to build the first class construction as described previously the pipe frame construction is considered as a good investment. This form of construction has met with approval in many parts of the States during later years and many houses of this style are to be found in Ontario. However, the growers in the United States who have had these houses are now building houses using the iron frame construction and the majority state they have better houses and are more satisfied with results. Men intending building small houses which will be used only as plant houses will find this form of construction best suited to their needs in many cases. The cost is not so high as those of the iron frame style but the difference is not so much as to warrant building a large range of the pipe frame construction. Both forms are giving good service but the preference is toward the more substantial and lasting form of houses.

DESCRIPTION.

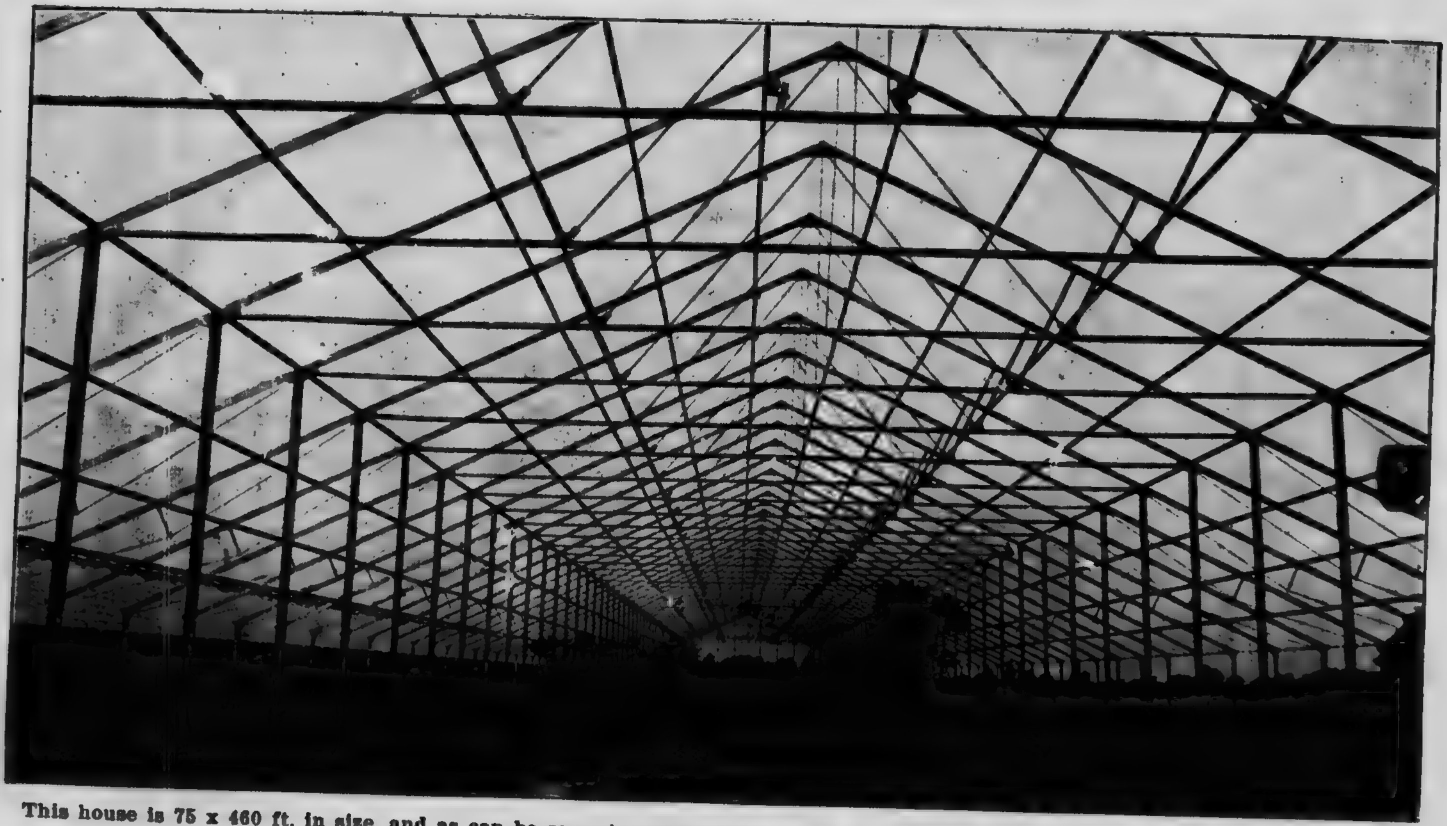
In this form of construction all the supporting members are made of iron pipe—eave or gutter supports, purlins and purlin supports. Galvanized iron pipe is used in all cases and all supporting members are set in concrete to a sufficient depth to make them solid. Wooden sash bars are placed on this frame work and held in position by means of a metal band or clasp which goes around the pipe purlin and is held to the bar by two screws.



Pipe frame construction, showing the network of pipes necessary to insure safety. Compare these views with the one on the next page.



Interior of largest pipe frame greenhouse in Canada.



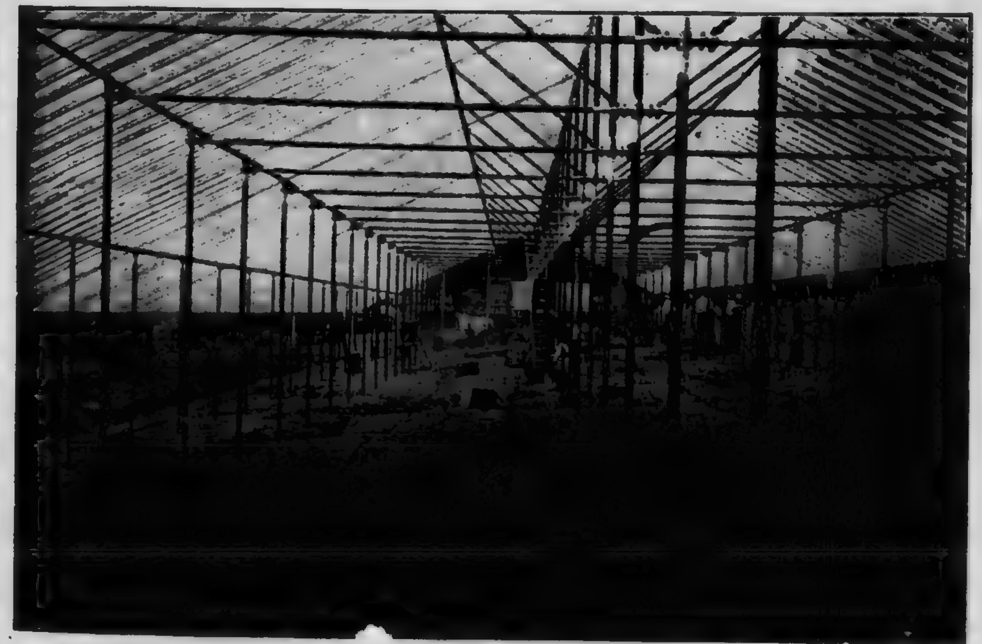
This house is 75 x 460 ft. in size, and as can be seen, two rows of supports are necessary with the iron frame construction, leaving 40 ft. clear in the centre.

ERECTION.

Here again any one with ordinary mechanical ability can erect one of these houses. Pipe can be bought cut and threaded as required by a local man and the grower can erect his own house. Care must be taken to have all parts set in line and at the correct height. A slight variance in setting supporting members will give endless trouble. Supporting members should be set on a solid foundation preferably concrete, and should be filled in around with concrete to a depth of eight inches. Usually growers have the concrete work come up above the surface of the ground some five inches to prevent the surface water from rusting the pipe. A common method is to place an ordinary field tile around the base of the pipe allowing it to come up above the surface and filling it in with concrete and moulding it off on top.

Supporting members have to be set so that there is a purlin every eight feet on the sash bar. These purlins have to be supported every eight feet. It has been found that to increase this distance increases the risk of solidity in the house. In some cases this has been tried with some degree of success but the grower took considerable risk in building such a house.

The purlins do not of necessity need to have their supporting members come directly from the ground in all cases. By using a V or Y brace the ridge support will carry two purlins as well. This does away with two rows of columns. In cases where this brace is used there should be a brace running from the eave support to the ridge support usually of three-quarter or one inch pipe held in position by split T's. These should be set high enough from the ground to permit operating



Angle iron purlins are sometimes used. The Y brace is used to lessen the number of supports.

crop, etc. Gable ends should be securely braced in this form of construction. The lack of these braces has been the cause of much damage in several large houses. During severe windstorms the end would give and the force of the wind would tend to wreck the whole house. Horizontal bars in the end should be used and these again supported from the lines of purlin supports. One and one-half inch and two inch pipe are usually used for supporting members and one inch and one and one-quarter as purlins depending on size and shape of houses.

MODIFICATIONS.

Instead of using the pipe purlins some growers have used angle irons. These are bored to fit screws which are attached to each sash bar. This method is used by some men and they claim to have a stronger house than with the pipe, claiming there is some danger of weakness at the coupling. The rigidity of the angle iron is said to overcome this. The difference in cost is very little, the angle iron costing a trifle more than the pipe. This modification is being used and is giving satisfaction in several large ranges but is not common.

OBJECTIONS.

The objection to houses of this form of construction is that a house of any size there are so many supporting members that the ground in the house cannot be cultivated with horses as easily as with other forms of construction. This appears to be true in large houses. Horses cannot be used with the same freedom as in houses requiring fewer supporting members. Some claim the columns being so close help to give more shade. Others claim there is very little difference.

Pipe frame houses have more material in them which must be kept up thus increasing running expenses. The same degree of solidity can not be found as in houses of the iron frame construction and there seems to be more danger of glass breakage in these houses than in the iron frame houses.

MERITS.

A very economical house for the man requiring only a small house to be used with raised benches. Cost of a small house is considerably less than if the construction were of iron frame.

ALL WOOD CONSTRUCTION.

This form of construction is practically out of date at the present time. It cannot be used economically because of the limited age of wooden parts. Wooden posts, usually cedar, are set four feet apart to form the side walls and the houses made very narrow requiring but few supports for the ridge. These have been found to be small trees cut required lengths, split cedar posts or two by four inch scantling.

Hot bed sash usually form the glass covering and these houses are sometimes called sash houses. This form of house is not to be recommended as a greenhouse. As a house used as a substitute for hot beds or cold frames it may be of some use in the early part of the season when it can be heated with a coal or wood stove. Many gardeners have used these houses in previous years and know their limitations and no gardener is advised to build one.

SIDE HILL HOUSES.

Some years ago it was the custom to build a greenhouse on a side hill, using the side of the hill as one side and having the glass run on a gradual slope to the bottom of the hill. These were thought to be excellent houses, this probably being that one side of glass was saved and that the house was always free from heavy wind storms, etc., owing to its peculiar location. Of recent years this idea has been entirely changed, and the side hill houses are practically a thing of the past. Growers now demand light on both sides of the roof and also demand good side ventilation. This cannot be had with ordinary side hill houses. Another objectionable feature of houses built on the hill side is that the beds or benches all must be on different levels as one goes down the hill. This entails extra labor and prohibits the possibility of horse cultivation. There are those who stick to the side hill house, but they are a very small minority, and the general opinion of growers is that the upright two sided greenhouse is what is required. Some men have ideal locations for greenhouses of the hill slope style but refrain from building, because they realize that they are money in pocket by paying for increased ventilation and the decrease of labor cost.

VENTILATION.

Ventilation of the greenhouse is a necessity for the growing of any crop. Too much attention cannot be given this part of construction, and the most approved arrangements and forms of ventilating apparatus should be carefully inspected before the installation of any. Ventilators are now being used on both sides of the house and in continuous runs, both sides of the ridge, and also in continuous runs, or in broken or alternate runs. Gable end vents are also being advocated and used by some progressive growers. These are not common as yet, but some men claim to have had a marked degree of success with them. They are arranged in different ways and as yet seem to be more the ideas of individual growers.

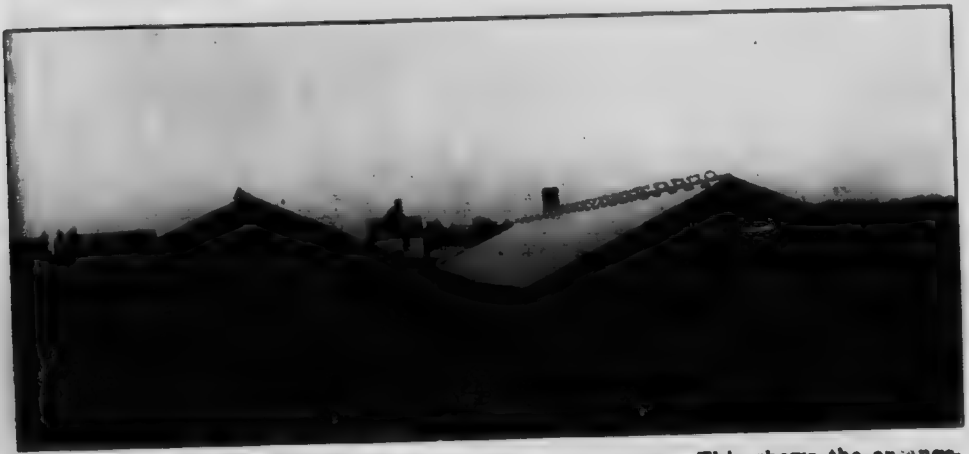
Side ventilation is necessary in large plants. Continuous runs of ventilator are usually located at the eave or lower. Usually made to open out, but some have them opening both in and out.

Side Ventilation.—The eaves of the greenhouse should be built high enough to permit the installation of plenty of ventilators along the side. Particularly where the summer crop of cucumbers is to be grown. This crop, for best results, requires side ventilation as well as ventilation of the ridge. There are various ways of setting those side ventilators and a brief description of each may be of value. The ventilator may take up practically the whole of the glass surface of the side of the house or it may be limited to less. As a general rule too much ventilation on the side cannot be had. Some growers prefer one continuous run of ventilation, three or six lights in length and two or three lights wide. Others claim to have equal success with about one-half the amount of ventilation given by means of making the ventilators come alternate with equal sized spaces of stationary glass. Side ventilators are used either opening directly beneath the eave plate or opening from a header set right below the eave. Both give satisfaction and both have their advocates. Possibly those preferring the ventilator to be continuous and opening from the header are in the majority.

Ventilators at the ridge may open from the ridge or from a header. Both ways are good. The majority prefer them to open from ridge. Continuous runs or broken runs as shown are in favor.

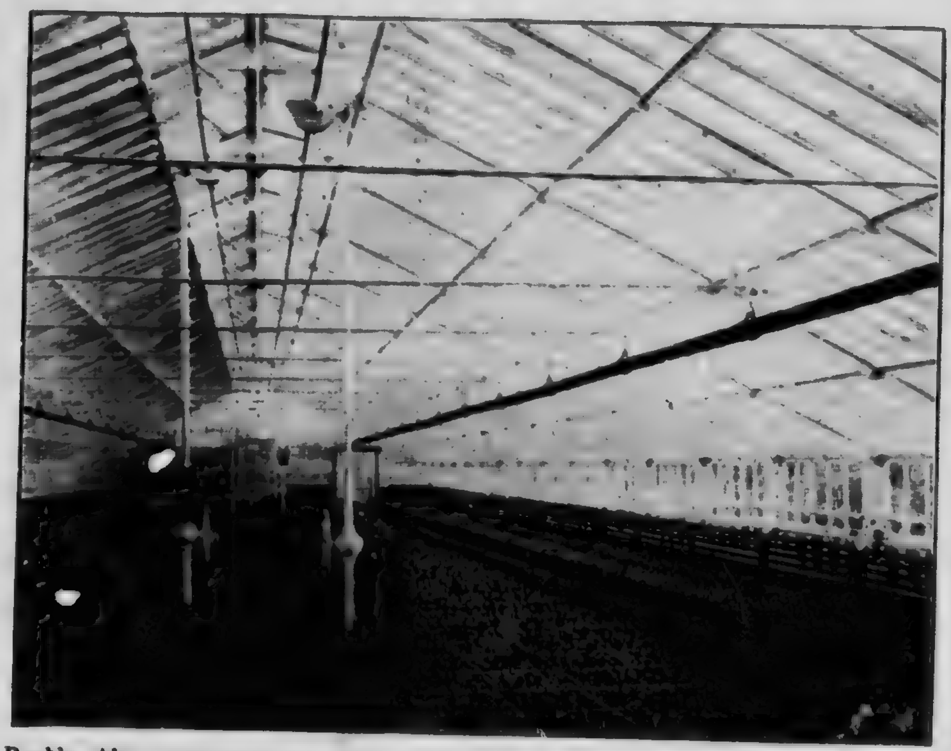
Ridge Ventilation.—This placing of ventilators has been in use since greenhouses were built on any scale and they are still a necessity. The ventilators in this case are attached in two ways, namely, from the ridge board or from the header set between the sash bars. In this way the vents open out from the ridge and from the headers or more easily explained opening back to back and away from one another. From this arrangement we have in the case of one opening from the header the air admitted in one large opening and going straight down into the house and in the case of those opening from the ridge the air is admitted through two openings, the air being deflected against the ventilator on the opposite side before going down. In this way the force of the air is broken.

Where ventilators open from the header there is greater danger from the rain getting in even if the ventilator is partially closed. Where the ventilator opens from the ridge the air can come in with very little danger of any rain getting in. An important point to be considered in ridge ventilation, whether ridge or header type, is that both lines should work separate in order that in the case of a strong wind from one side the ventilators on that side may be closed, while the others will remain open and complete ventilation of the house still be carried on. Some growers complain that the ridge type of ventilators allow an inward rush of air which has caused severe checks on the plants, while in the header type this rush is broken and the air admitted is distributed evenly through the house.



Gable end ventilation as yet is the idea of some one grower. This shows the arrangement of the ventilators which open out. Houses also have ridge and side ventilators.

Gable end ventilation is probably more or less of an experiment as yet, but it is being advocated by some plant owners. They would advise a continuous or broken line of ventilators on a wide, high house set in a horizontal position or two or three small vents in a perpendicular position. In both cases these vents should be above the door. It is quite possible that very little more ventilation will be needed in many houses than that given by the door, which should be built sufficiently large enough to be used for admitting a waggon. All forms of ventilators are usually operated by a system of ventilating machinery which is controlled by a wheel or a chain driving some form of gear which by revolving will open the ventilators. Many forms are on the market, and it is difficult to choose as each and every device has its exponents. In large houses a system running 150 to 200 feet should be secured in order to open the maximum amount of glass with minimum labor. For the smaller houses, growers in many cases do not buy ventilator machinery, but have some appliance such as an iron rod with holes drilled in it, which, when the vent is opened fit on to nails set on the plate. These may be all right in some cases, but as a general rule, in any house 20 by 60 ventilating apparatus will pay for itself in the amount of labor saved. Where two systems are necessary to open up the glass they should be located so that both can be operated from the one point, preferably the centre of the house, instead of being located at both ends of the house thus necessitating extra labor.



Double ridge ventilation and side ventilators on both sides are found in this house. Ridge ventilators operated in centre of house by two gear supports.

JOINED OR SEPARATE HOUSES.

At the present time there is considerable controversy about the merits of joined or separate houses. Growers in the east use separate houses almost entirely while those around Chicago have used ranges of joined houses. It appears on investigation that where wide houses are being built, separate ones are used entirely.

Joined and separate houses are often found in the same range. In such cases the grower nearly always prefers the separate house and advocates this arrangement only.

Ranges of narrow houses are giving good satisfaction but the growers are building their new ones of wide separate houses. The merits of the separate houses may be given briefly as follow

(1) Side ventilation is recognized as a necessity among vegetable growers, and this can be secured amply by having separate houses.

(2) Different temperatures may be kept in different houses thus enabling the growing of crops requiring several degrees difference in temperature.

(3) Heating systems can be built so as to shut off entirely one house if the occasion should so demand.

(4) Disease is not so liable to spread from one house to another.

OBJECTION TO JOINED HOUSES.

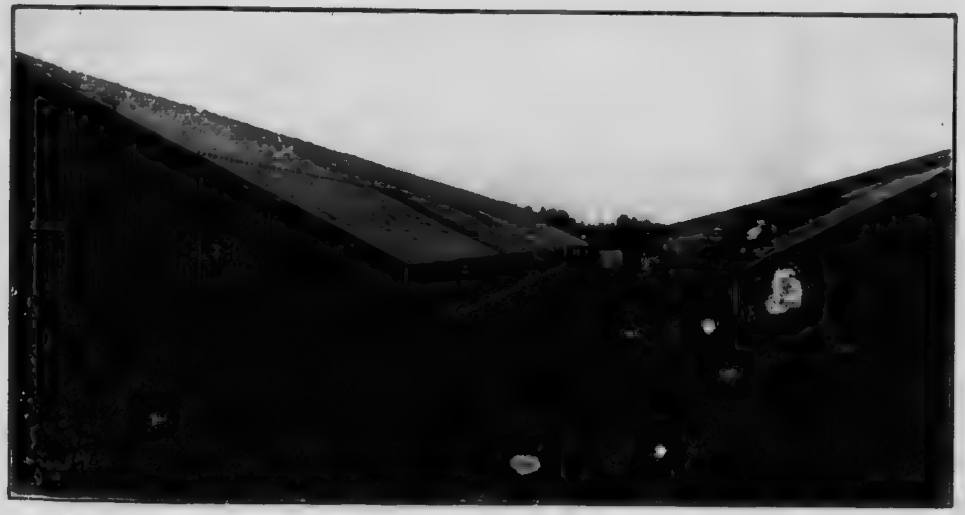
(1) Where the range is large adequate side ventilation cannot be secured.

(2) Unless glass partitions are erected in joined houses different crops requiring high and low temperatures cannot be successfully grown.

(3) Heating cannot be regulated in case of accident, etc.

(4) In joined houses disease will spread quickly from one house to another.

In regard to the heating of the two styles of houses it is claimed by owners of large ranges that there is very little difference in the cost. Of course some claim exorbitant saving on their particular houses but this cannot always be verified. On the whole separate houses can be heated with practically the same cost as houses on the connected style.



Large houses built separately are usually joined by an alley house from 10 to 30 ft. in length. The space between the houses is often utilized for hot beds, cold frames, and for such crops as corn, squash, staked tomatoes or rhubarb.

Alley houses are usually built connecting the separate houses for convenience of carrying supplies, etc., and the heating main is usually carried through these minimizing the loss of heat.

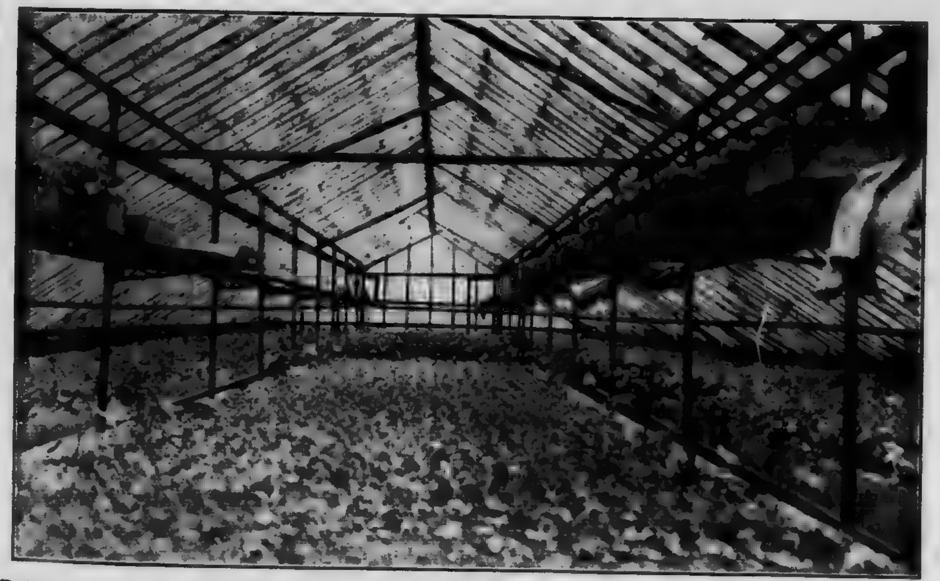
WALKS.

In the majority of large plants visited, no permanent paths or walks were to be found. In all houses having raised benches a path would be found in between beds. The growers at the present time seem to be eliminating everything that hinders the most intensive cultivation of the soil under glass. Where all crops are grown on the soil, and where horses are used to prepare the soil for the crop, no paths are to be found, because they would be more of a hindrance than a help. Sufficient room is left at intervals in planting the crop to allow for passage between. In the majority of cases the ordinary greenhouse soil is trodden down until it becomes solid for walking. In some cases men lay a ten or twelve inch board down the house and use this for a walk. Never a slat walk 18 inches or two feet, this would be a waste of productive soil. In other houses concrete walks are to be found. These are usually about 12-15 inches wide, and are made on either side of a line of purlin supports, or as close to the gutter supports as possible, leaving all room possible for the growing of the crop.

Walks are usually 12 to 15 in. wide, allowing ample room for crop to grow.

More elaborate houses have a concrete walk with a 3-5 inch side, which acts as a side for the bed, being 3-4 inches high. These walks are never more than 18 inches in width. Where a house is fitted out in this manner there is usually some good reason for it, which usually amounts to the grower having easy access to a sand or gravel pit or that the paths are a necessity to accommodate the visitors. In making concrete walks the foundation should be down about 5-6 inches. Coarse stones and gravel will do for this, and should be made at the ratio of 6-1 with cement. A smooth surface on top is necessary, no stones being allowed to come near the surface. A well pounded cinder path will give satisfaction, but is not so good as concrete where a path is absolutely necessary.

Concrete walks should be placed so as to enable ease of cultivation. Eaves should be high enough to permit walking under. This view is of ten acres under glass near Toledo, Ohio.



Raised benches are necessary where rhubarb is forced. In narrow pipe frame houses iron supports are often clamped to the supports to make a shelf for early plant boxes.

BEDS OR BENCHES.

A question which must be decided before the heating system is installed is whether the crops are to be grown on beds or benches. For many years it was taken for granted that the crops must be grown as close to the glass as possible, and for this reason the houses were built with short sides and the crops were grown on benches raised up from the surface of the soil to about four or five feet, thus bringing the plants fairly close to the roof. During late years this idea has almost entirely disappeared, and lettuce, tomatoes, and cucumbers are set in the soil as it has been enclosed by the glass house. No raising of beds is to be found in any of the larger plants where vegetables are grown extensively. There are certain points in favor of both of these methods and it may be of interest to go over them briefly here. In a greenhouse 75 by 200, for example, all operations of cultivation, etc., are carried on by means of horses. Plowing, harrowing, disking and spreading of manure, lime or fertilizer are all done by means of horse drawn implements, and for this reason no raised benches are found in houses of this kind. It is quite obvious why plants can be handled quicker and with less labor on ground beds and such operations as tying of supports, staking or even transplanting can be carried on much more satisfactorily. Growers find that they can grow any crop just as satisfactorily on solid beds as on the raised benches used by many growers for years.

In case of a small house, say 22 by 80, where the grower is not making a specialty of indoor crops, but is using the house more as a plant house for early plants such as cabbage, tomatoes, onions and celery, etc., the raised benches are very often used with success. Conditions are entirely different in houses of this width, and it is quite possible that better results may be had from raised benches for starting early plants. Watering can is controlled more easily and that is a prime necessity in a plant house. In houses of this size, and using raised benches, their height from the soil will depend on the grower's individual ideas. Some prefer them only two and one-half feet from the surface, others three feet up to four feet. A very good bench is one raised three feet from the top of the surface soil. Heating pipe will have to be laid under this to get the best results, and as a general rule a section of the return runs are brought back under the benches. Where it is desired to force rhubarb in the greenhouse the raised benches serve the purpose better than any other method. There is sufficient room for the plants, the heat can be controlled, the plants are out of the way, and the darkening can be controlled as well.

Points against the use of raised benches are:—

1. Initial cost is very high and so is the upkeep, as the benches are continually rotting out.
2. Cultivation cannot be easily handled.
3. A great deal of space is wasted by paths, etc.

Raised benches seem to be the best thing for the small greenhouse grower, because he can force his rhubarb or grow his mushrooms under them, and he is not pressed for time, etc., and uses the house more as a plant house, making what returns he can during the winter months. For the commercial grower the solid beds are recommended and give entire satisfaction on good soil which has the proper drainage, etc.

The benches are supported by cedar posts or by solid concrete supports, the latter being fitted with an enlarged base which sits on the ground and supports either wooden or concrete sides. Ordinary pine or hemlock is often used for these benches, but most florists prefer cypress on account of its lasting powers, and pecky cypress is coming into favor more each year. Pipe supports are now being used considerably for the support of benches, and give very good satisfaction. The width of the bench, etc., would determine the size of bracing of pipe. Benches for use in vegetable houses usually have six to eight inches of soil.

WORKROOMS.

Not the least important part of the greenhouse is the workroom. The crop has to be handled right in the plant several times before it can be shipped out, and all or most of this work must be done in the workroom. Greenhouse men are beginning to realize that this room must be a permanent, well built structure, sufficiently large to handle all the crop, and not become congested at any time.

Usually the workroom is located close to the boiler room in as central a position as possible. The boiler house will have to be set according to the location of the plant, so as to heat economically each part of the house or houses. As a general rule the workrooms are built to one end of the boiler room. Light, airy, convenient rooms are best.

A brief description of some rooms seen might be of value.

R. Yonkers, Grand Rapids, Mich. Boiler room and workroom end to end. Building constructed of concrete blocks laid with red mortar, size 30 by 50 feet. Angle iron rafters with truss supports, several large casement windows, concrete floors throughout with drains, concrete wash tubs and a bench for dripping at right hand of tub. A small division is made to form an office in which all accounts, etc., are kept. The whole room is lighted with electricity. Door on front is large enough to allow waggon or motor truck to be backed in and loaded handily from the packing floor. All woodwork is painted and the whole inside is of a pleasing appearance and spotlessly clean.

Greenhouse plants require good workrooms. More attention is being paid to them each year. Each labor-saving device should be well considered before being installed.

R. L. Reutenik, Cleveland, Ohio. Workrooms located along ends of houses. Concrete floors and wooden walls. Here again permanent wash tubs and tables are found. Here the waggon is backed into another shed which is at one end of the workroom and the bottom of the waggon is set lower down than the floor of the workroom so that the boxes do not have to be lifted so high in loading. This room is also well lighted and fairly airy.

Goldwood Greenhouse Co., Cleveland. New plant with boiler room and work room together. Concrete is used as main form of construction, plenty of windows, electrically lighted and wash tubs, etc. The particular point is that waggon may be backed into excavated part and goods may be loaded on the level. No lifting whatever is needed on this account.

The builder in Ontario will do well to realize the importance of these large airy rooms. Small cooped up workrooms are not an advantage and the produce tends to become mangled. The points mentioned particularly about the above houses are labor savers and have been well considered before they were adopted. Men who have to drive their produce to market have found out that lettuce loaded in a fairly warm room and securely covered has a better selling value than lettuce carried out into the frosty air to be loaded. Little points like these are what are making money for these men in the greenhouse business on the other side and some might well be copied here.

GLASS AND GLAZING.

Too much importance cannot be given by the builder to these points. The outside surface of the greenhouse is that which receives the direct blows, and it must be strong enough to withstand the severest storms.

There are many grades of glass on the market which have been sold as suitable for greenhouse building. Ordinary window glass will not do; a stronger grade is necessary. A heavier grade of glass is used for greenhouses. The glass should be carefully gone over and all lights having flaws or whorls in them should be discarded. Burning of the crops underneath will result from the strength of the sun's rays. Another point which should be remembered here is that of evenness of edge. This is absolutely necessary where success is expected with butted glass.

Sizes 16 by 24 inch glass is the most popular size in the U. S., while many growers use even a larger size. Some using as large as 20 by 30 in districts where there is litle danger from hail or from very severe wind storms. 16 by 24 is used in different ways laying it the 16 inch way and the 24 inch way, thus placing the sash bars 16 inches apart and 24 inches apart. Some growers claim that there is considerably less breakage when the bars are laid to hold the 16 inch glass. In other sections it seems to be the rule to use glass the same width as above, but 12 inches in length. This still gives the bars 16 inches apart, but makes the joints come just twice as many as with the 16 by 24 inch glass. This method uses the same amount of supports, but is not in favor by the majority of growers owing to the fact that there are such a number of joints or laps whichever the case may be. Growers prefer the 16 by 24 inch glass, and take the chance of heavy breakage bills. In Ontario, glass 20 by 20 inches in size is the most popular among those having plants of any size. This gives a good light, and is convenient for use with bar and cap, which is the common method of putting on the glass in Ontario houses. Owing to the square there is double the chance of securing a tight fitting joint, as the four sides of the glass may be fitted. This is a good size of glass to use, giving plenty of light, and being not too large so as to increase the breakage cost; 16 by 16 inch glass can also be used and for the same reasons. It is not advisable to use glass of a larger size than 16 by 24 in Ontario, and most growers will not chance that size, preferring to take a little more shade but lessening the repairs and using either 16 by 16 or 20 by 20.

Butted or Lapped Glass.—Butted glass is commonly to be found on greenhouses in Ontario, and means that the sash bar is so constructed as to allow the glass to be laid on, one light butting against the next one up, and then a wooden strip which fits on to the bar is screwed on, and this holds down the side of the glass.

Lapped glass is commonly, almost entirely, used in the United States. This means that the glass is laid up in the same manner as shingles, one light overlapping the one underneath it. The lap is usually 3/16 or ¼ inch. Any more makes a poor job and dirt collects in the small space, and becomes very unsightly and causes a certain amount of shade. With the lapped glass construction the glass is usually bedded in putty, while with the bar and cap no putty is used nor no glazing point. A zinc strip attached to the gutter or eave holds the bottom light in place and the others above rest on it. If lapped glass is to be laid, only first class greenhouse putty should be used. Ordinary putty secured from a hardware store will not do. It will crack and peel off in about two years time, necessitating going over the whole house again.

This grade of putty will cost a few cents more per pound but will save in the long run. It cost some growers in the States this last year several hundreds of dollars to re-putty their houses because they used an inferior putty at the start. This can be procured from any reliable firm who make and handle greenhouse materials.

Glass should be laid convex side up or with the bowed side to the weather. practically all American houses are equipped with lapped glass, and practically all Ontario houses have butted glass. The butted glass is handier in some cases to put on in case of breakage, and yet the close fits and the jagged edges sometimes found tend to cause more breakage. If there is any jar or move of the frame one piece of glass is pushing against another in the case of the butted glass, whereas with the lapped glass the one light has a chance to slide on the one beneath before it will break. Lapped glass properly bedded in putty will give a warmer house than the butted one. There is always an opening between the best butted glass, and this allows for the escape of warm air and permits rain and moisture to get in. More unsightly houses, due to collecting of dirt on the lights which has run in through the butt opening and down the inside of the light, will be found than from dirt collected under the lap in a well bedded house.

The objections to lapped glass encountered more than anything else was that it was awkward to fit a broken light. This point was admitted by many growers, but they have a counter claim that the breakage is not one-quarter that of a butted glass house. The glass in the latter is simply shoved in at the bottom, thus shoving all the lights up until there is sufficient room for the light being replaced.

Glass comes in boxes holding 100 square f[illegible] There is always more or less breakage in them, but the builder should i[illegible] that he is given D. D. English 21 oz. glass or he should get double strength (D.S.) American glass.

HEATING.

Hot Water Heating.—The heating is the next point which must be considered. Hot water and steam are the two sources of heat for greenhouses yet. A great deal can be said for and against each kind of heating, and it is a problem to say which is used the most. Both systems have been improved in the last 10-15 years, and both systems are built to give maximum service. Hot water heating may be divided into two systems; the gravity system and the pressure system. [illegible] the gravity system the water circulates from the boiler through the coil [illegible]ack into the boiler again, because after it reaches a certain point there is a [illegible] in the pipe system and the water naturally seeks its own level. The pressure system is where there is some device which forces the water on its own course over the pipe system. This is usually a mercury generator or some form of pump. Both of these machines have their advocates, and many have success with either. The gravity system has its limitations, however, and the first one is that the water cannot be carried over 150 ft. of coil away from the boiler with good success. Some plants are working to-day at 200 ft. away from the boiler, but the best results are not being obtained because of overloading the boiler. Some growers claim that the highest point of the heating system should be at the boiler, thus giving the water a drop all the way into the boiler again. The pipes should have a drop of ten inches per 100 ft., for successful running of the gravity system. With the mercury generator or some form of circulator the water can be forced over 400 ft., this being over twice the distance of the gravity system. The pipes do not need so much grading in this form of heating. In this system the water is forced through at a greater rate than by gravity, and it comes back to the boiler containing more degrees of heat than that which has passed over the system working according to the laws of gravity. This point means more than is often thought, and should be investigated thoroughly before any system is selected. The longer the water takes to travel around a heating system the less number of degrees of heat it contains when it again comes to the boiler. All this water has to be heated over again, and thus it is quite apparent the more degrees the water has to be raised in temperature the more units of heat required and this falls back again and increases the consumption of coal.

The gravity system is to be recommended for small houses such as 30 or 40 by 100 or 150 but may be used up to 30,000 square feet of glass. For larger houses, and where there are several in a range and hot water is wanted, some form of circulator is recommended. There are some good pumps on the market, and as a rule they are run by steam. A small steam boiler is necessary for the pump alone. One of these is giving good service at the Goldwood greenhouse near Cleveland, Ohio. Another method used in the vicinity of Rochester is that of a centrifugal pump operated by a 1/5 h.p. electric motor. This system has given entire satisfaction, and the cost for power is very small. This method is not a common one and should be inquired into thoroughly before being attempted. Hot water heating is never recommended for plants having much over 100,000 sq. ft. of glass but this will no doubt be overcome in the future.

STEAM HEATING.—For long houses and for large houses or large ranges the use of steam is advised. In these cases where the heat has a long way to travel it can be carried to a better advantage and with a less cost of fuel by the steam system. There are several systems of steam heating which may be installed, but there are only two of these that have been satisfactorily applied to greenhouse heating. These are the high pressure and the low pressure systems.

The low pressure system is used to a great extent and this is one that operates at a pressure of 1-10 lbs., usually 5-6. This works by gravity and the condensation is carried back to the boiler without any circulator of any kind. This system necessitates that the boiler must be several feet below the lowest return in the house. This is the limiting factor for this system as it is not always convenient to have the boilers in a pit as this entails. This pit may be overcome and the boilers placed on a level with the houses by the addition of a steam trap which lifts the water into the boiler from the returns. This arrangement is found in many plants giving good satisfaction. Here again the steam pump may be used to draw back the condensation but the steam trap is more effective and is less liable to get out of repair.

The other system of steam heating used in greenhouses to some extent is known as the high pressure system and is where over ten pounds of pressure is carried at the boiler, reducing it as desired for the houses and bringing the condensation back by means of steam traps or pumps. This system should only be attempted on large ranges and then installed by men competent to do so.

A vacuum system of heating is being installed in some plants and works on the principle of high pressure at the boiler and by the use of reducing valves and vacuum pumps the steam passes through the coils in the houses at atmospheric pressure or under. This form of heating for large plants is recommended as the most economical now, but must be properly installed by competent men to be worked successfully.

ADVICE TO PROSPECTIVE BUILDERS.

(1) All construction companies keep a staff of men whose business it is to give all information in regard to their forms of construction. They are there for the builders' benefit.

(2) Find out all about the different makes before making your selection.

(3) Do not give an order for material until you are satisfied it is exactly what you require.

(4) If in doubt ask or write some grower who will give you an unbiased opinion and knows whereof he speaks.

(5) Successful growers follow the rules "the best is none too good" and "a poor thing is dear at any price."

(6) Construction companies are used to building large ranges and will give you the benefit of their experience in regard to location, site, etc.

(7) Insist that all the accessories such as nails, ventilating apparatus, putty, paint, etc., be of first class and that they are properly used.